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THE PSYCHOSOCIAL IMPACTS OF EXPOSURE TO ENVIRONMENTAL
CONTAMINANTS IN ONTARIO: A FEASIBILITY STUDY

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INTRODUCTION

Public concern in Ontario over the possible toxic effects of exposure to environmental contaminants is high in the wake of past highly publicized events elsewhere, for example, Love Canal, Three Mile Island, and Chernobyl. Local situations, such as the Upper Ottawa Street Landfill Site in Hamilton, reinforce concerns and give them more immediacy. Recent disclosures regarding PCB disposal sites, radon gas emissions and electro-magnetic radiation also contribute to uncertainty and anxiety over health risks. Equally, the prospect of the future location of new solid and liquid waste disposal sites compounds public fears and generates community reaction.

Research on the human health consequences of environmental contaminants has focussed primarily on possible physical effects (e.g. cancer outcomes). Increasing attention is now being given to psychosocial morbidity, in part as a result of research undertaken in the wake of such high profile events as the accident at Three Mile Island (e.g. Sorenson et al., 1987; Vynner, 1988).

Superficially, the link between exposure to contaminants and negative psychosocial outcomes (e.g. anxiety, depression, domestic and interpersonal problems) is self-evident. On closer examination, however, current knowledge based on past research is fragmentary, and a necessary starting point for future investigation is a critical appraisal of the existing literature. Recent reviews (Madisso, 1985; Michalenko and Lerner, 1987) provide a general description of the types of research attempted and the main findings reported but do not provide a critical appraisal of the evidence contained in previous studies.

This paper describes the development and application of a methodology for assessing the literature on the psychosocial impacts of environmental contaminants. The methodology was devised as part of a feasibility study for which the eventual end point is a protocol for research on the psychosocial impacts of environmental contaminants in Ontario. Although the intended purpose of the methodology is quite specific, the governing principles of critical appraisal on which it is based are quite general. It follows that the method has potential application to the assessment of research on a broad range of environmental health issues.

OVERVIEW OF THE METHODOLOGY

The methodology was designed with the following critical appraisal objectives in view:

To assess the strength of the evidence for causal links between exposure to environmental contaminants and psychosocial impacts.

To develop a conceptual model of the process linking exposure to environmental contaminants and psychosocial impacts.

To assess the strengths and weaknesses of feasible research designs for the study of psychosocial impacts.

To evaluate existing instruments for measuring psychosocial impacts of exposure to environmental contaminants.

To assess analytical/statistical methods for estimating relationships between exposures and outcomes.

To evaluate approaches for determining the exposure characteristics of populations.

To identify population sub-groups particularly susceptible to psychosocial impacts.

To review the implications for public education of the psychosocial impacts of exposure to environmental contaminants.

The methodology divides into three stages: literature search, screening and appraisal. The first two are straightforward and require only brief comment. The appraisal procedure is more complex and needs fuller description and explanation.

Literature Search:

Increasingly, researchers have come to depend on computer-based bibliographic search methods. The scope has increased as the size and number of computerized bibliographic data bases has multiplied. In the present case ten different data bases were searched (BIOSIS, Enviroline, Environmental Bibliography, Medline, NTIS, Pollution Abstracts, Popline, Psyc Info, Sociological Abstracts, and Toxline).

The initial search strategy was to use combinations of generic keywords for both exposure (e.g. 'environment', 'toxic', 'pollution', 'waste', 'risk') and impacts (e.g. '(di)stress', 'psycho', 'socio', 'health', 'behaviour'). This global approach was ineffective and inefficient. It generated literally thousands of citations, many of which were irrelevant, and several key citations were missed.

A revised strategy involved searching each data base for "key" citations to determine salient keywords specific to that bibliography. These were then used for a second comprehensive search. This was far more productive, but still failed to

identify some important references uncovered by preliminary manual search methods.

This experience is not unusual for users of bibliographic data bases in situations where the target literature is quite diverse (i.e. in this case, a wide range of relevant environmental contaminants and psychosocial outcomes) and therefore spread across a wide range of journals and classified using an unstandardized set of keywords. Consultation with other researchers in the field confirmed similar difficulties in identifying relevant literature on this topic using computerized search methods.

The net result was that it was necessary to supplement the automated search procedures with conventional manual methods. This involved a systematic search of all issues of relevant journals back to 1980. The journal list was defined in two ways: first, any journal containing a previously identified relevant article was included; second, potentially relevant journals listed as "high impact" in the Science Citations Index were added.

Citations identified by this combination of automated and manual methods were entered into a bibliographic data base using Word Perfect 4.2 for efficient data storage and retrieval.

Literature Screening

The list of citations generated by the search inevitably included items of varying relevance for the study objectives. A screening form was developed to identify articles for full appraisal. The screening form included three classification criteria: type of effect (physical, psychosocial), type of exposure (environmental, occupational) and type of publication (original research, methodology, review, conceptual, book, discussion/commentary). All citations dealing with relationships between environmental exposures and psychosocial effects qualified for full appraisal.

LITERATURE ASSESSMENT

The literature on the psychosocial impacts of environmental contaminants is diverse and calls for an innovative appraisal methodology. A literature assessment form was developed to fulfill two purposes: to summarize the content of each paper; and to evaluate the strength of evidence with reference to standardized methodological criteria. The form was the product of extensive discussion among the research team. Draft versions were pretested and revised as appropriate. A user's manual was written to ensure consistency in application of the form by assessors.

Content Summary Criteria

Check lists were developed to summarize the content of articles under five headings: study design; health outcome; exposure classification; sample design; and analysis methods.

Study design is a very important consideration in assessing the strength of evidence. The epidemiologic literature provides detailed discussion of design architecture and its implications for causal inference. Designs for environmental epidemiology are typically one of three generic types: cohort, case-control and cross-sectional (Marsh and Caplan, 1986; Kasl, 1985). In addition, a variety of other designs are used (e.g. ecologic, time series and ethnographic).

A "diagnostic tree" was devised to determine the design used in each of the studies under review (Fig. 1). This consisted of a sequence of diagnostic questions. 'Yes'/'no' answers to each question defined a specific design type. For example, a design was classified as 'epidemiologic'/'individual level'/'cross-sectional' if the answers to the diagnostic questions were as follows:

"Does the study review and quantitatively summarize 'primary data' studies?" NO

"Does the study attempt quantitative inferences about the risk of any health outcome associated with exposure to environmental hazards?" YES

"Does the study analyze a risk/exposure relationship using human individuals as the unit of analysis?" YES

"Are all exposures and health outcomes referent to the same point in time?" YES

The classification of health outcomes in the target literature is complex because of the wide range of physical and psychosocial effects reported. Although not the primary focus of the inquiry, it was essential to include physical effects because they are frequently reported in combination with psychosocial outcomes. Indeed, self-reported physical symptoms may in themselves represent psychosocial effects. A comprehensive checklist was devised to reflect current thinking about morbidity. Lists were written under five major categories: disease outcome (by body system and type); objectively measured dysfunction (physical, neuropsychological and psychological), illness stigma (physical, emotional and cognitive complaints), illness behaviour (health concerns and help-seeking), and disability

(vocational/educational, activities of daily living, domestic and interpersonal, social and recreational).

Exposure definition is also complex. It is important to consider several aspects. Six classification categories were included in the appraisal form: experience, source, pathway, culprit, economic benefit and public familiarity. Several of these deserve brief comment.

It is important to document the nature of the exposure experience. The distinction is made between actual (past or present), future and perceived exposure, although these are not mutually exclusive. Psychosocial effects are frequently reported in situations where actual exposure either has never occurred or is in doubt. This is obviously the case where effects occur in advance of the presence of a contaminant (e.g. anxiety in anticipation of a future waste disposal site). Equally, effects are reported in response to perceived past or present exposure which may bear little relation to measures of actual contamination. Another important distinction is between acute (e.g. accident situations) and chronic (e.g. industrial emissions) exposure. The (supposed) source of contamination (e.g. landfill site, heavy industry, ambient conditions) is significant given the perceived risk attached to certain types of facility (e.g. nuclear power plants) and the heightened awareness and mistrust which may ensue. The presence or absence of a 'culprit' for contamination affects whether there is an identifiable target for the expression of public concern and may influence the types of coping responses in an impacted community. Risk perception and reported effects may be related to the economic benefit, if any, attached to the source of contamination. This is especially evident in single industry towns where the pollution source is the major employer and fundamental to the economic base of the community. The inclusion of familiarity reflects the importance of prior public knowledge of contaminants and their possible health consequences. Knowledge about local risks may arise in a variety of ways; for example, from media coverage of comparable situations elsewhere or from the activities of local environmental groups.

For sample design and analysis, the appraisal form included items to cover details of sample size, composition and representativeness, and the specific types of statistical or other analytical methods employed.

Assessment of Evidence Criteria

The second part of the appraisal form was designed to provide a systematic basis for evaluating the strength of evidence reported in each of the papers under review. While there exist general epidemiologic principles for an evaluation exercise of this sort (Frank et al., 1988; McMaster Univ., 1981), there was no "off the

shelf" instrument suited to the specific literature in view. Items were developed for inclusion in the appraisal form to address the following major issues: the measurement of exposure to contaminants; the measurement of health outcomes; control of extraneous/confounding variables; strength of association; evaluation of study results; global assessment of credibility.

It follows from the earlier discussion on the nature of the exposure experience related to psychosocial effects that the identification and measurement of exposure is inherently problematic. Thorough documentation of the type, intensity and duration of exposure is unlikely in most studies. Typically, effects are reported in response to an uncertain 'dose' of uncertain contaminants. The problem is compounded when perceived exposure is considered, given that this can occur in the absence of any actual contamination at all. These complications notwithstanding, items were included in the appraisal form to determine how, if at all, exposure agents had been identified and measured. In the same context, items to determine the use and adequacy of control groups were developed. An item was also included to assess exposure to 'health alarms' in the community (e.g. public health warnings, media reports, etc.) recognizing the potential influence they could exert on public reaction and reported effects.

The assessment of outcomes was considered in terms of appropriateness and accuracy. Appropriateness is related to the biological/psychological and epidemiological plausibility of the outcomes reported with reference to the contaminants in question. This is typically a difficult assessment to make for psychosocial outcomes because of their complex and uncertain causation and the absence of specific links to particular exposures. In short, a wide range of outcomes are plausibly related to an equally wide range of exposures. An additional issue is the timing of the outcomes relative to the exposure taking account of any latency period that might be involved. The assessment of accuracy involves sensitivity (i.e. few false negatives), specificity (i.e. few false positives) and bias (e.g. self-reported effects). The frequent use of self-report measures of undetermined reliability and validity complicates the assessment of accuracy. Confounding variables are factors related to both exposure and outcome which, if not controlled in the study design or analysis, may lead to false inference about an exposure-outcome relationship. From the standpoint of assessment, it is relevant to determine the use and characteristics of control groups and particularly their comparability to the exposed population. Specifically, it is important to determine the adequacy of matching and/or the methods used to adjust for possible confounders in the analysis. Here again, the complex and uncertain causation of psychosocial effects is problematic because it is difficult to compile a full list of potential confounders. It is reasonable to suppose that various

sociodemographic variables (age, gender, socioeconomic status) are relevant. It may be important to consider psychological factors as well (e.g. personality traits).

Strength of association corresponds to the change in risk of an outcome occurring after exposure to an imputed cause. Two questions arise in assessing relative risk, namely its clinical or practical significance and its statistical significance. Items were included in the appraisal form to assess both. These two aspects of significance are not necessarily coincident. A relative risk may be judged clinically significant though not statistically significant (e.g. small sample sizes may preclude statistical significance despite a relative risk of clinically significant proportions). Alternatively, a statistically significant result may have uncertain clinical significance (e.g. if the outcome in question has undetermined health consequences). A third consideration regarding strength of association is the demonstration of a dose-response relationship (i.e. risk increases monotonically with increased exposure) and an item was included to judge this. Where a relationship is present there is strong evidence of a true effect. On the other hand, its absence may be due to many factors and it is therefore not a definitive criterion. The frequent absence of precise exposure measures for reasons already described precludes the calculation of dose-response relationships in many studies.

The overall evaluation of reported results comes down to the question of whether the demonstrated exposure-effect link is true positive, false positive, true negative or false negative. All of the evaluation criteria previously described have to be taken into account to make this judgment. Three items were included in the appraisal form to judge the possibility of a false positive association, a false negative association and the consistency with other studies of the same exposure-effect relationship. The last of these is made more difficult if the exposure and outcome in question are not well understood from previous research.

Three final items were included on the appraisal form to provide a global assessment based on all of the previous criteria. The first required a judgment as to whether the evidence supported an association for each exposure-outcome relationship examined. The second item determined if there were other factors which might cast doubt on the validity of the association (e.g. temporality, biological/psychological credibility, consistency with other studies). The last item called for a bottom line judgment on the credibility of the study.

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APPLICATION OF THE METHODOLOGY

Results of the Literature Search and Screening

The combination of automated and manual literature search methods previously described resulted in the compilation of a bibliography containing 296 citations. These were classified according to the three major criteria (type of effect, type of exposure, and type of publication) on the screening form. Classification codes were included with each citation in the bibliography which was stored as a Word Perfect (secondary merge) file. Search and selection within this file allowed for the generation of subfiles defined by user-specified requirements (e.g. original research studies of relationships between environmental exposures and psychosocial effects.)

The frequency distribution of citations according to the screening criteria is summarized in Table 1. As intended by the choice of search strategy and keyword selection, most citations deal with psychosocial effects (263) and environmental exposures (192). 164 studies involve a combination of these two. Both physical and psychosocial effects are quite frequently examined within a single study (68 citations). An exposure-effect relationship was examined in 175 cases. In terms of type of publication, 'original research' is the most frequent category (160) followed by 'conceptual' (81) and 'discussion/commentary' (64).

The subset of studies for full appraisal was defined as those which examined a relationship between environmental exposure and psychosocial effects based on original research. 52 citations satisfied these criteria. These are the key papers for addressing the first of the objectives previously listed: to assess the strength of evidence for causal links between exposure to environmental contaminants and psychosocial impacts. The balance of the citations are the basis for a more general review of the literature in fulfillment of the other stated objectives.

Appraisal Procedure

Prior to the appraisal of the 52 papers, an inter-rater reliability test was conducted. This involved three team members making independent assessments of six papers using the appraisal form. The papers were selected to represent the range of topics in the full set of 52. The results showed a high degree of consistency among raters. The test did reveal some differences in interpretation of specific items on the form. These were reported to the full team and agreement was reached on standard interpretations.

At the time of writing the appraisal is nearing completion. The procedure has been for two team members to make independent

assessments of each paper. These are then checked for consistency. Differences in judgments on content summary items are in most instances resolved by checking the relevant factual details in the paper. Differences on the assessment of evidence items are resolved by discussion between the two assessors. Where this fails to achieve consensus, a third party from the research team is called on to reach a majority judgment. Consistent with the pretest findings, the differences have been relatively few and resolution has in almost all cases been achieved by consultation between the two original assessors.

Customized software has been developed for data entry from the appraisal form. This provides a VDT screen image of the form to facilitate data entry. The package is menu driven with facilities to modify and retrieve data and to copy user defined files. The modification procedure allows for the addition, deletion or correction of information. The retrieval facility is flexible allowing access by title, author, key words or particular appraisal items (e.g. study design, outcome, exposure). The software can create files for input to other programs (e.g. SPSSX) to facilitate further analysis (e.g. contingency analyses).

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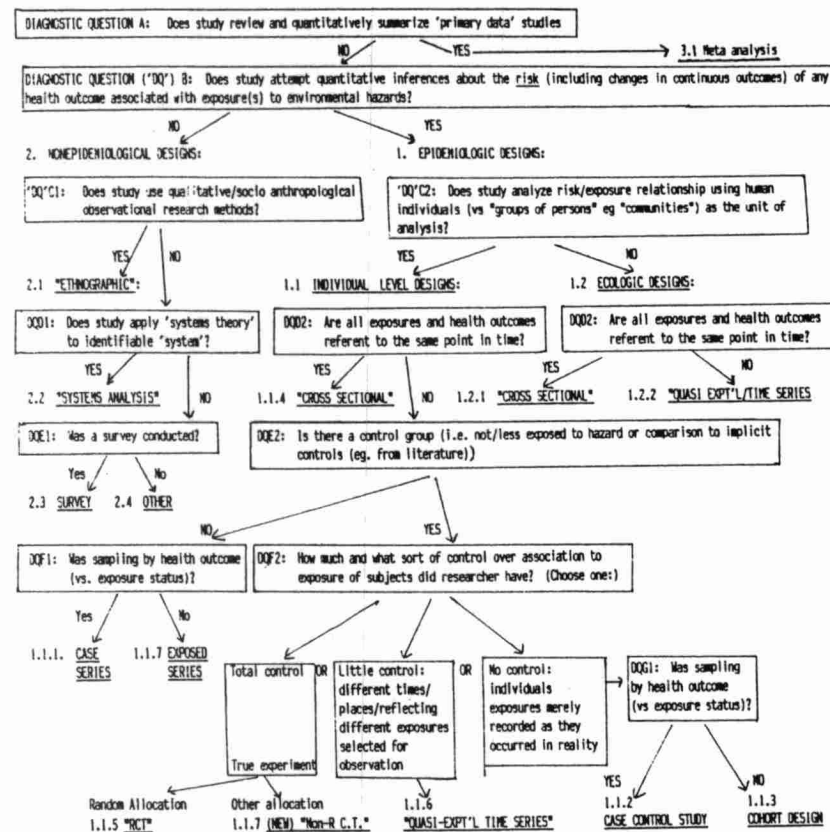
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TABLE 1
FREQUENCY DISTRIBUTION OF CITATIONS

CATEGORY	FREQUENCY
HEALTH EFFECT	
Psychosocial	263
Physical	79
EXPOSURE	
Environmental	192
Occupational	82
EXPOSURE-EFFECT RELATIONSHIP ASSESSED	175
TYPE OF STUDY	
Original Research	160
Conceptual	81
Methodology	63
Review	53
Commentary	64
Book	22
TOTAL CITATIONS	296

Figure 1
STUDY DESIGN DIAGNOSTIC TREE





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